The effect of relative reputational concerns in sequential deliberation models

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Abstract:

The payoff of an employee often not only depends on his own reputation, but on the reputation of his peers as well. This is caused by the fact that they generally move up the corporate ladder through promotions, for which they compete with their direct colleagues. However, most papers on reputational concerns do not take this into account. This paper finds that, in a game-theoretical sequential deliberation model with relative reputational concerns, agents have an extra incentive to either mirror or contradict (depending on their *ex-ante* reputations) the decision of other agents, compared to a similar model without relative reputational concerns. Agents with an *ex-ante* reputation that is higher than that of their colleague have an incentive to mirror the decision of their colleague. Agents with an *ex-ante* reputation that is lower than that of their colleague have an incentive to contradict the decision of their colleague.

Introduction

In a market with imperfect information, managers do not always have all the information they need to make a well-advised decision on their own. Therefore, they often rely on agents to make decisions for them. However, relying on an agent can also have negative consequences. First of all, the interests of the agent might not be in line with those of the managers. Furthermore, agents may differ in their competence to gather and interpret the information needed to make the decision. To appear to be competent, and thus improve their reputation, agents may sometimes benefit from not advising according to their own vision or signal. The literature (which is discussed further down below) on these phenomena is quite vast. However, most of it fails to take one important characteristic of businesses into account. Namely, the way agents compete with their peers.

In general, agents move up on the corporate ladder by receiving promotions. Since most companies have a pyramid-shaped hierarchy, the demand for a promotion outweighs the supply. When a promotion comes up, the agent who appears to be the most suitable gets chosen. This implies that the payoff of employees is not only influenced by the ability of an employee, but it also depends on the ability of his colleagues. So, in the case of the agents in our model, the payoff of an agent is not only based on his own (absolute) reputation, but also depends on the reputation of other agents.

I will look at the implications this has in a model in which two agents sequentially give their advice on an investment decision. In such a model, the second agent has an (extra) incentive to either mirror or contradict the decision of the first agent: The agent with the best reputation has an incentive to mirror, so the other agent cannot overtake his reputation. The agent with the worst reputation has an incentive to contradict, so he can overtake the reputation of the other agent. Note that this only applies when the reputations of the agents are sufficiently close.

Literature review

In a model with only one agent, (Ricart i Costa & Holmstrom, 1986) and (Holmstrom, 1999) show that agents may not act in the best interests of their managers, as a result of different risk preferences when the payoff of a project is unobservable when the manager does not invest.

When there is more than one agent, there are additional problems that arise: (Scharfstein & Stein, 1990) use a model that closely resembles the model that is used in this paper, but with payoffs equal to agents' absolute reputation and no prior information about the agents' competence. They find that, under certain assumptions, the second agent will follow the decision of the first agent, ignoring his private information. They call this phenomenon herd behaviour. (Ottaviani & Sørensen, 2001) show that this effect is stronger when an agent with a high reputation speaks first.

When agents make decisions in committees, (Meade & Stasavage, 2008) find that agents are hesitant to make statements that differ from the views of other agents in the committee. They test this empirically by comparing deliberations in the *Federal Reserve's Federal Open Market Committee*, before and after they decided to release transcripts of their meetings. They find evidence that their hypothesis is correct.

Furthermore, (Fehrler & Hughes, 2016) compare a scenario in which the manager observes the individual messages to a scenario in which he only observes the decision of the committee. They find that less transparency decreases herding behaviour, and thereby improves the gathering of information. They test their hypotheses empirically in a lab experiment and find that this result largely holds.

The idea that relative reputational concerns might affect decision making is not new: (Scharfstein & Stein, 1990) and (Ottaviani & Sørensen, 2001) note that relative reputational concerns might influence their results.

Furthermore, (Rosen, 1981) describes the phenomena of superstars, in which a small number of people dominate the activities in which they engage. In such a scenario, relative reputational concerns have a large influence on the actions of agents. (Nalebuff & Stiglitz, 1983) find, that when employees' payoff depends on their relative performance, they exert an amount of effort that is closer to the optimal amount of effort from the manager's perspective, compared to a payoff depending on absolute performance.

(Effinger & Polborn, 2001) shows that relative reputational concerns gives agents an incentive to oppose the decision of other agents, if an agent is more valuable when he is the only smart agent. The biggest difference between (Effinger & Polborn, 2001) and this paper is that in their paper, agents have the same initial reputation, whereas they differ in this paper.

Relative reputational concerns may also have effects on models without sequential deliberation, for instance, because it gives an incentive to withhold information from other agents. Since this is not the specific topic of my thesis, I will not discuss this literature very thoroughly. But to give an idea of other theories that might be affected by relative reputational concerns I will briefly discuss a few papers:

(Prendergast, 1993) shows that agents have an incentive to conform to the initial opinion of their managers. (Morris, 2001) finds that agents who have preferences that are identical to those of their managers have an incentive to lie about their private information if the manager thinks the agent might be biased, to impact future decisions. Finally, (Suurmond, Swank, & Visser, 2004) find that competent agents will exert more effort when gathering private information, to distinguish themselves from incompetent agents.

Model

A firm employs two agents, who have to advice the firm whether or not to make a certain investment. First, one of the agents ($Agent$ 1) gives his advice. This will be observed by the second agent ($Agent$ 2), who will then give his advice. The payoff of the project can be either positive or negative. The payoff is denoted by $x \in \{\mathrm{H}, \mathrm{L}\}$. The payoff of the project is positive (H) with probability 0.5 and negative (L) with probability 0.5. The payoff will become public knowledge after both agents have made their decision, irrespectively of whether one of the agents decided to invest. Prior to making their decision, both agents get one of two possible signals regarding the outcome of the investment: Their signal is denoted by $s_i \in \{\mathrm{G}, \mathrm{B}\}$. G signals that the payoff will be positive and B signals that the payoff will be negative. The message that an agent sends to the manager is denoted by $m_i \in \{\mathrm{g}, \mathrm{b}\}$.

Furthermore, there are two types of agents: Smart agents (an agent is smart with probability θ_i) and dumb agents (an agent is dumb with probability $1 - \theta_i$). θ_i is public knowledge. To clarify: the agents (can) have different initial reputations. The agents do not know their own type, but they do know their own initial reputation and the initial reputation of their colleague. The firm knows this as well.

A smart agent's signal is imperfectly informative and will correspond to the actual outcome of the project with probability $p \in \left(\frac{1}{2}, 1\right)$. In other words, the signal is more likely to be right than wrong, but it might still be wrong. A dumb agent's signal will be completely uninformative, his signal will correspond to the actual outcome of the project with probability 0.5. The *ex-ante* distribution of signals is the same for both types of agents, so they do not learn anything about their type from the message itself:

$$\Pr(G|smart) = 0.5p + 0.5(1-p) = 0.5$$

$$\Pr(G|dumb) = 0.5 * 0.5 + 0.5 * 0.5 = 0.5 = \Pr(G|smart)$$

The agents do not care about the payoff of the project, their payoff only depends on their reputations. An agent's absolute reputation equals the probability that he is smart, given his initial reputation, advice and the payoff of the project (calculated using *Bayes' law*). The *ex-post* absolute reputation of $Agent$ 1 is denoted by $\widehat{\theta_1}(m_1, x)$ and the *ex-post* absolute reputation of $Agent$ 2 is denoted by $\widehat{\theta_2}(m_1, m_2, x)$. Furthermore, this is a one-shot game.

The payoff π_i for $Agent\ i$ depends on both his own reputation and the reputation of his colleague, $Agent\ j$. It equals:

$$\pi_i = \begin{cases} \widehat{\theta_\iota} & if \widehat{\theta_\iota} > \widehat{\theta_J} \\ \lambda\widehat{\theta_\iota} & if\ \widehat{\theta_\iota} < \widehat{\theta_J} \end{cases}$$

Where $\lambda \in (0,1)$

First we will calculate the reputation of the second agent in the equilibrium in which both agents follow their own signal: $s_i = m_i$. Then we will check whether and when this is a Nash-equilibrium, by checking whether $Agent$ 2 has an incentive to deviate. We will do the same in a model that is exactly these same, except for the payoff, which equals $\pi_i = \widehat{\theta_\iota}$. This way we can show the impact of adding relative reputational concerns to the model.

Results

An agent can receive 2 possible signals: G and B. For both these scenarios, the state can be both H and L. resulting in a total of 4 scenarios. Since the signals of the agents are independent and identically distributed and we assume that agents follow their own signal, the absolute reputation of an agent does not depend on the message of the other agent.

First, we calculate the *ex-post* absolute reputation of the agent with the highest initial reputation when he sends message g and the state of the world is H. Recall that we assume that $s_i = m_i$.

$$\widehat{\theta_\iota}(g, H) = \Pr(smart|g, H)$$

$$\widehat{\theta_\iota}(g, H) = \frac{0.5\theta_i p}{0.5\theta_i p + 0.5 * 0.5(1 - \theta_i)}$$

$$\widehat{\theta_\iota}(g, H) = \frac{0.5\theta_i p}{0.5\theta_i p + 0.25(1 - \theta_i)}$$

To clarify: The numerator equals the probability that a smart agent receives signal $s_i = G$ when the state of the world is H equals $0.5\theta_2 p$. The denominator contains the same probability, with the addition of the probability that a dumb agent receives signal $s_i = G$ when the state of the world is H, which equals $0.25(1 - \theta_2)$.

The other 3 combinations are calculated in the same way.

$$\widehat{\theta_\iota}(b, H) = \frac{0.5\theta_i(1 - p)}{0.5\theta_i(1 - p) + 0.25(1 - \theta_i)}$$

$$\widehat{\theta_\iota}(g, L) = \frac{0.5\theta_i(1 - p)}{0.5\theta_i(1 - p) + 0.25(1 - \theta_i)}$$

$$\widehat{\theta_\iota}(b, L) = \frac{0.5\theta_i p}{0.5\theta_i p + 0.25(1 - \theta_i)}$$

As can be seen from both the calculations, as well as argued through symmetry:

$$\widehat{\theta_\iota}(g, H) = \widehat{\theta_\iota}(b, L)$$

$$\widehat{\theta_\iota}(b, H) = \widehat{\theta_\iota}(g, L)$$

We will investigate the effect of relative reputational concerns on the behaviour of agent 2. For both combinations of signals we will check whether and when agent 2 has an incentive to deviate[1] in both the model with and the model without relative reputational concerns. Then we will compare the behaviour of agent 2 in both models.

First we have to prove that the rank of the agents stays the same when they both give the same advice:

$$\widehat{\theta_2}(g,H) > \widehat{\theta_1}(g,H) \; can\ be\ derived\ to\ \theta_2 > \theta_1$$

$$\widehat{\theta_2}(b,H) > \widehat{\theta_1}(b,H) \; can\ be\ derived\ to\ \theta_2 > \theta_1$$

Furthermore, we have to calculate the probability of the project generating a positive payoff, given the signals of both agents: $\Pr(H|m_1, s_2)$

$$\Pr(H|g,G) = \frac{\Pr(G,G|H)\Pr(H)}{\Pr(G,G)}$$

$$\frac{\big(\theta_1\mathrm{p} + 0.5(1-\theta_1)\big)\big(\theta_2\mathrm{p} + 0.5(1-\theta_2)\big)0.5}{0.25}$$

$$\Pr(H|b,B) = \frac{\Pr(B,B|H)\Pr(H)}{\Pr(B,B)}$$

$$\frac{(\theta_1(1-\mathrm{p}) + 0.5(1-\theta_1))(\theta_2(1-\mathrm{p}) + 0.5(1-\theta_2))0.5}{0.25}$$

$$\Pr(H|g,B) = \frac{\Pr(G,B|H)\Pr(H)}{\Pr(G,B)}$$

$$\frac{(\theta_1\mathrm{p} + 0.5(1-\theta_1))(\theta_2(1-\mathrm{p}) + 0.5(1-\theta_2))0.5}{0.25}$$

$$\Pr(H|b,G) = \frac{\Pr(B,G|H)\Pr(H)}{\Pr(B,G)}$$

$$\frac{(\theta_1(1-\mathrm{p}) + 0.5(1-\theta_1))(\theta_2\mathrm{p} + 0.5(1-\theta_2))0.5}{0.25}$$

[1] In this case, deviating means deviating from the equilibrium in which everyone follows their signal. So preferring to lie about his signal, given that agent 1 followed his own signal.

Behaviour of agent 2

There are 4 possible combinations of messages and signals (m_1, s_2): (g,G) (agent 1 sends message g and agent 2 receives signal G); (b,B); (g,B); (b,G). In all these scenarios, the payoff of the project can be both H and L, resulting in a total of 8 scenarios per agent. Since (g,G) is symmetric to (b,B) and (g,B) is symmetric to (b,G), we will only discuss (g,G) and (g,B).

Combination $(\boldsymbol{g}, \boldsymbol{G})$

Model without relative reputational concerns

Agent 2 has an incentive to deviate if the expected value from fooling his manager into thinking that he has received signal B, is higher than the expected value of following his signal (which is G). Thus, he will deviate if:

$$\widehat{\theta_2}(b,H)\Pr(H|g,G) + \widehat{\theta_2}(b,L)\Pr(L|g,G) > \widehat{\theta_2}(g,H)\Pr(H|g,G) + \widehat{\theta_2}(g,L)\Pr(L|g,G) \quad (1)$$

$$\widehat{\theta_2}(b,H)\Pr(H|g,G) - \widehat{\theta_2}(g,H)\Pr(H|g,G) > \widehat{\theta_2}(g,L)\Pr(L|g,G) - \widehat{\theta_2}(b,L)\Pr(L|g,G)$$

$$\Pr(H|g,G)\left(\widehat{\theta_2}(b,H) - \widehat{\theta_2}(g,H)\right) > \Pr(L|g,G)\left(\widehat{\theta_2}(g,L) - \widehat{\theta_2}(b,L)\right)$$

Since $\widehat{\theta_i}(g,H) = \widehat{\theta_i}(b,L)$ and $\widehat{\theta_i}(b,H) = \widehat{\theta_i}(g,L)$:

$$\Pr(H|g,G)\left(\widehat{\theta_2}(b,H) - \widehat{\theta_2}(g,H)\right) > \Pr(L|g,G)\left(\widehat{\theta_2}(b,H) - \widehat{\theta_2}(g,H)\right)$$

Since $\widehat{\theta_2}(b,H) < \widehat{\theta_2}(g,H)$:

$$\Pr(H|g,G) < \Pr(L|g,G)$$

This expression is never satisfied.

Model with relative reputational concerns

When the rank of an agent does not change, his reputation changes in the same way as in the model without relative reputational concerns. Consequently, for the relative reputational concerns to influence his decision, there must be a possibility of changing ranks. Since $\lambda \in (0,1)$, a higher rank is strictly better.

- ***If $\boldsymbol{\theta_2} > \boldsymbol{\theta_1}$***

Agent 2 already has the highest reputation, therefore he runs the risk of losing his high relative reputation, if he deviates and the payoff turns out to be H. Meanwhile, he does not have the opportunity to improve his reputational rank, if he decides to deviate and the payoff turns out to be L. Since deviating will also decrease his absolute reputation, he will always follow his own signal.

If $\theta_2 < \theta_1$

Agent 2 already has the lowest reputation, therefore he has the opportunity to overtake the reputation of agent 1, if he deviates and the payoff turns out to be L. Meanwhile, he does not run the risk of lowering in rank, if he decides to deviate and the payoff turns out to be H.

Agent 2 will deviate if both:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,G) + \widehat{\theta_2}(b,L)\Pr(L|g,G) > \lambda\widehat{\theta_2}(g,H)\Pr(H|g,G) + \lambda\widehat{\theta_2}(g,L)\Pr(L|g,G) \quad (2)$$

And:

$$\widehat{\theta_2}(b,L) > \widehat{\theta_1}(g,L) \quad (3)$$

- *Comparison*

Equation (2) solves to:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,G) + \widehat{\theta_2}(b,L)\Pr(L|g,G) > \lambda\widehat{\theta_2}(g,H)\Pr(H|g,G) + \lambda\widehat{\theta_2}(g,L)\Pr(L|g,G)$$

Since $\widehat{\theta_\iota}(g,H) = \widehat{\theta_\iota}(b,L)$ and $\widehat{\theta_\iota}(b,H) = \widehat{\theta_\iota}(g,L)$:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,G) + \widehat{\theta_2}(g,H)\Pr(L|g,G) > \lambda\widehat{\theta_2}(g,H)\Pr(H|g,G) + \lambda\widehat{\theta_2}(b,H)\Pr(L|g,G)$$

$$\lambda\widehat{\theta_2}(g,H)\Pr(H|g,G) + \lambda\widehat{\theta_2}(b,H)\Pr(L|g,G) - \lambda\widehat{\theta_2}(b,H)\Pr(H|g,G) < \widehat{\theta_2}(g,H)\Pr(L|g,G)$$

$$\lambda\left(\widehat{\theta_2}(g,H)\Pr(H|g,G) + \widehat{\theta_2}(b,H)\Pr(L|g,G) - \widehat{\theta_2}(b,H)\Pr(H|g,G)\right) < \widehat{\theta_2}(g,H)\Pr(L|g,G)$$

$$\lambda < \frac{\widehat{\theta_2}(g,H)\Pr(L|g,G)}{\widehat{\theta_2}(g,H)\Pr(H|g,G) + \widehat{\theta_2}(b,H)\Pr(L|g,G) - \widehat{\theta_2}(b,H)\Pr(H|g,G)}$$

$$\lambda < \frac{\widehat{\theta_2}(g,H)\Pr(L|g,G)}{\Pr(H|g,G)\left(\widehat{\theta_2}(g,H) - \widehat{\theta_2}(b,H)\right) + \widehat{\theta_2}(b,H)\Pr(L|g,G)}$$

Since $\widehat{\theta_2}(b,H) < \widehat{\theta_2}(g,H)$, the expression on the right is always positive.
Whether this equation is satisfied, depends on the values of θ_1, θ_2, λ and p, thus it is not always satisfied.

Furthermore, Equation (3) solves to:

$$\widehat{\theta_2}(b,L) > \widehat{\theta_1}(g,L) \quad (3)$$

$$\frac{0.5\theta_2 p}{0.5\theta_2 p + 0.25(1-\theta_2)} > \frac{0.5\theta_1(1-p)}{0.5\theta_1(1-p) + 0.25(1-\theta_1)}$$

$$\theta_2 > \frac{2}{3p - \theta_1 + p\theta_1 - 1}$$

Whether this equation is satisfied, depends on the values of θ_1, θ_2 and p, thus it is not always satisfied.

Combination $(\boldsymbol{g}, \boldsymbol{B})$

Model without relative reputational concerns

Agent 2 has an incentive to deviate if the expected value from fooling his manager into thinking that he has received signal G, is higher than the expected value of following his signal (which is B). Thus, he will deviate if:

$$\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(g,L)\Pr(L|g,B)$$
$$> \widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) \quad (4)$$

$$\widehat{\theta_2}(g,H)\Pr(H|g,B) - \widehat{\theta_2}(b,H)\Pr(H|g,B) > \widehat{\theta_2}(b,L)\Pr(L|g,B) - \widehat{\theta_2}(g,L)\Pr(L|g,B)$$

$$\Pr(H|g,B)\left(\widehat{\theta_2}(g,H) - \widehat{\theta_2}(b,H)\right) > \Pr(L|g,B)\left(\widehat{\theta_2}(b,L) - \widehat{\theta_2}(g,L)\right)$$

Since $\widehat{\theta_i}(g,H) = \widehat{\theta_i}(b,L)$ and $\widehat{\theta_i}(b,H) = \widehat{\theta_i}(g,L)$:

$$\Pr(H|g,B)\left(\widehat{\theta_2}(g,H) - \widehat{\theta_2}(b,H)\right) > \Pr(L|g,B)\left(\widehat{\theta_2}(g,H) - \widehat{\theta_2}(b,H)\right)$$

Since $\widehat{\theta_2}(g,H) - \widehat{\theta_2}(b,H) > 0$:

$$\Pr(H|g,B) > \Pr(L|g,B)$$

$$\theta_1 > \theta_2$$

Model with relative reputational concerns

- ***If $\boldsymbol{\theta_2} > \boldsymbol{\theta_1}$***

Agent 2 already has the highest reputation, therefore he runs the risk of losing his high relative reputation, if he does not deviate and the payoff turns out to be H. Meanwhile, he does not have the opportunity to improve his reputational rank, if he decides not to deviate and the payoff turns out to be L.

Agent 2 will deviate if:

$$\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(g,L)\Pr(L|g,B) > \widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) \quad (4)$$

Or if both:

$$\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(g,L)\Pr(L|g,B) > \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) \quad (5)$$

And:

$$\widehat{\theta_2}(b,H) < \widehat{\theta_1}(g,H) \quad (6)$$

- *Comparison*

Since $\theta_2 > \theta_1$, Equation (4) is never satisfied in this scenario.

Furthermore, since:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) < \widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B)$$

Equation (4) is less likely to be satisfied than Equation (5), but Equation (5) is always satisfied whenever Equation (4) is satisfied.

Furthermore, Equation (5) solves to:

$$\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(g,L)\Pr(L|g,B) > \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) \quad (5)$$

Since $\widehat{\theta_i}(g,H) = \widehat{\theta_i}(b,L)$ and $\widehat{\theta_i}(b,H) = \widehat{\theta_i}(g,L)$:

$$\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(b,H)\Pr(L|g,B) > \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(g,H)\Pr(L|g,B)$$

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) < \widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(b,H)\Pr(L|g,B) - \widehat{\theta_2}(g,H)\Pr(L|g,B)$$

$$\lambda < \frac{\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(b,H)\Pr(L|g,B) - \widehat{\theta_2}(g,H)\Pr(L|g,B)}{\widehat{\theta_2}(b,H)\Pr(H|g,B)}$$

Whether this equation is satisfied, depends on the values of θ_1, θ_2, λ and p, thus it is not always satisfied.

Furthermore, Equation (6) solves to:

$$\widehat{\theta_2}(b,H) < \widehat{\theta_1}(g,H) \quad (6)$$

$$\frac{0.5\theta_2(1-p)}{0.5\theta_2(1-p)+0.25(1-\theta_2)} < \frac{0.5\theta_1 p}{0.5\theta_1 p + 0.25(1-\theta_1)}$$

$$\theta_2 < \frac{\theta_1 p}{p+\theta_1-2\theta_1 p-1}$$

Whether this equation is satisfied, depends on the values of θ_1, θ_2 and p, thus it is not always satisfied. If the agents' initial reputation is more equal, agent 2 is more likely to deviate.

- ***If $\boldsymbol{\theta_2 < \theta_1}$***

Agent 2 already has the lowest reputation, therefore he has the opportunity to overtake the reputation of agent 1, if he follows his own signal and the payoff turns out to be L. Meanwhile, he does not run the risk of lowering in rank, if he decides to follow his signal and the payoff turns out to be H.

Agent 2 will follow his own signal if:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(b,L)\Pr(L|g,B) > \lambda\widehat{\theta_2}(g,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(g,L)\Pr(L|g,B) \quad (7)$$

Or if both:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) > \lambda\widehat{\theta_2}(g,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(g,L)\Pr(L|g,B) \quad (8)$$

And:

$$\widehat{\theta_2}(b,L) > \widehat{\theta_1}(g,L) \quad (9)$$

- *Comparison*

Since Equation (7) can be rewritten to be the opposite to Equation (4) by dividing both sides by λ and since $\theta_2 < \theta_1$, this equation is never satisfied in this scenario.

Since:

$$\lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) > \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(b,L)\Pr(L|g,B)$$

Equation (8) is more likely to be satisfied than Equation (7), and Equation (7) is always satisfied whenever Equation (8) is satisfied.

Furthermore, Equation (8) solves to:

$$\lambda\widehat{\theta_2}(g,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(g,L)\Pr(L|g,B) < \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(b,L)\Pr(L|g,B) \quad (8)$$

Since $\widehat{\theta_i}(g,H) = \widehat{\theta_i}(b,L)$ and $\widehat{\theta_i}(b,H) = \widehat{\theta_i}(g,L)$:

$$\lambda\widehat{\theta_2}(g,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(b,H)\Pr(L|g,B) < \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) + \widehat{\theta_2}(g,H)\Pr(L|g,B)$$

$$\lambda\widehat{\theta_2}(g,H)\Pr(H|g,B) + \lambda\widehat{\theta_2}(b,H)\Pr(L|g,B) - \lambda\widehat{\theta_2}(b,H)\Pr(H|g,B) < \widehat{\theta_2}(g,H)\Pr(L|g,B)$$

$$\lambda\left(\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(b,H)\Pr(L|g,B) - \widehat{\theta_2}(b,H)\Pr(H|g,B)\right) < \widehat{\theta_2}(g,H)\Pr(L|g,B)$$

$$\lambda < \frac{\widehat{\theta_2}(g,H)\Pr(L|g,B)}{\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(b,H)\Pr(L|g,B) - \widehat{\theta_2}(b,H)\Pr(H|g,B)}$$

Furthermore, Equation (9) solves to:

$$\widehat{\theta_2}(b,L) > \widehat{\theta_1}(g,L) \quad (9)$$

$$\frac{0.5\theta_i p}{0.5\theta_i p + 0.25(1-\theta_i)} > \frac{0.5\theta_i(1-p)}{0.5\theta_i(1-p) + 0.25(1-\theta_i)}$$

$$\theta_2 > \frac{\theta_1 - p\theta_1}{p + \theta_1 - 2p\theta_1}$$

Whether this equation is satisfied, depends on the values of θ_1, θ_2 and p, thus it is not always satisfied.

Analysis

To show the effect of relative reputational concerns on agent 2, we will examine various potential equilibria, using several propositions.

Proposition 1: *Without reputational concerns, there exists a perfect Bayesian equilibrium in which agent 2 follows his own signal.*

From Equation (1) we can see that agent 2 will always follow his own signal when it corresponds to the message of agent 1. However, Equation (9) shows that agent 2 will not follow his own signal if it does not match the message of agent 1 and agent 1 has a higher reputation. Thus, without reputational concerns, there does there exists a continuation equilibrium in which agent 2 follows his own signal, but only if $\theta_2 > \theta_1$.

Proposition 2: *Without reputational concerns, there exists a perfect Bayesian equilibrium in which agent 2 follows the signal of the agent with the highest initial reputation.*

From Equation (1) we can see that, when agent 2's signal corresponds to the message of agent 1, he will follow this signal. Since both agents received the same signal, this is also the signal that the agent with the highest initial reputation received. Furthermore, Equation (9) shows that, when the signal of agent 2 does not match the message of agent 1, he will follow his own signal if $\theta_2 > \theta_1$, and the message of agent 1 if $\theta_2 < \theta_1$. In other words, he will follow the signal of the agent with the highest initial reputation.

Thus, without reputational concerns, there always exists a continuation equilibrium in which agent 2 follows the signal of the agent with the highest initial reputation. When agent 2 has the lowest initial reputation, his message will not hold any new information and will therefore be ignored by the manager.

Proposition 3: *With reputational concerns, there exists a perfect Bayesian equilibrium in which agent 2 follows his own signal.*

Whether agent 2 will receive a signal that is corresponding or contradicting to the message of agent 1 has a big impact on his behaviour. Therefore, we will look at these two cases individually.

- **When $m_1 = s_2$:**

When agent 2 has the highest initial reputation, not following his signal will decrease both his absolute and his relative reputation, therefore he will always follow his own signal.

When agent 2 had the lowest initial reputation, not following his signal will hurt his absolute reputation (according to Equation 1) and possibly improve his relative reputation (according to Equations 2 and 3).

Agent 2 will only deviate if both:

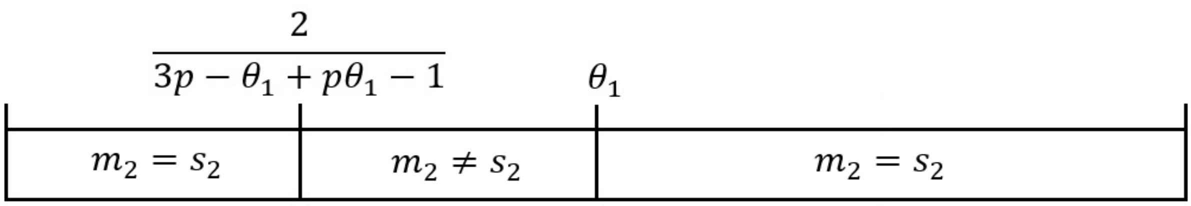
$$\lambda < \frac{\widehat{\theta_2}(g,H)\,\Pr(L|g,G)}{\Pr(H|g,G)\left(\widehat{\theta_2}(g,H) - \widehat{\theta_2}(b,H)\right) + \widehat{\theta_2}(b,H)\,\Pr(L|g,G)}$$

And:

$$\theta_2 > \frac{2}{3p - \theta_1 + p\theta_1 - 1}$$

The first expression shows that, the more relative reputation has an impact on agent 2's payoff, the more he is inclined not to follow his own signal. The second expression shows that agent 2 will only deviate if his initial reputation is only slightly lower than that of agent 1.

When both agents receive the same signal, this graph illustrates the behaviour of agent 2 for different initial reputations (when we ignore whether or not λ is satisfied):



- **When $m_1 \neq s_2$:**

When agent 2 has the highest initial reputation, not following his signal will secure his relative reputation and hurt his absolute reputation (according to Equation 4).

Agent 2 will only deviate if:

$$\lambda < \frac{\widehat{\theta_2}(g,H)\,\Pr(H|g,B) + \widehat{\theta_2}(b,H)\,\Pr(L|g,B) - \widehat{\theta_2}(g,H)\,\Pr(L|g,B)}{\widehat{\theta_2}(b,H)\,\Pr(H|g,B)}$$

And:

$$\theta_2 < \frac{\theta_1 p}{p + \theta_1 - 2\theta_1 p - 1}$$

The first expression shows that, the more relative reputation has an impact on agent 2's payoff, the more he is inclined not to follow his own signal. The second expression shows that agent 2 will only deviate if his initial reputation is only slightly higher than that of agent 1.

When agent 2 has the lowest initial reputation, not following his signal will take away his opportunity to improve his relative reputation, but it will improve his absolute reputation (according to Equation 4).

Agent 2 will only deviate if both:

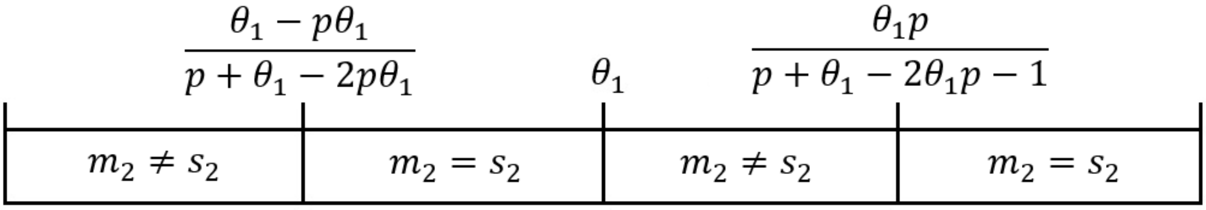
$$\lambda > \frac{\widehat{\theta_2}(g,H)\Pr(L|g,B)}{\widehat{\theta_2}(g,H)\Pr(H|g,B) + \widehat{\theta_2}(b,H)\Pr(L|g,B) - \widehat{\theta_2}(b,H)\Pr(H|g,B)}$$

And:

$$\theta_2 < \frac{\theta_1 - p\theta_1}{p + \theta_1 - 2p\theta_1}$$

The first expression shows that, the more relative reputation has an impact on agent 2's payoff, the more he is inclined to follow his own signal. The second expression shows that agent 2 will only deviate if his initial reputation is only slightly lower than that of agent 1.

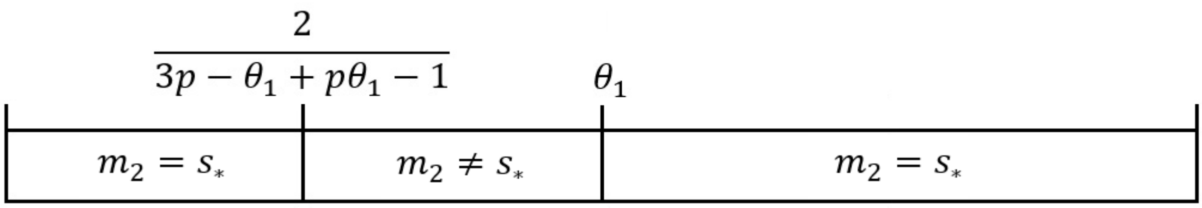
When the agents receive contrasting signals, this graph illustrates the behaviour of agent 2 for different initial reputations (when we ignore whether or not λ is satisfied):



Proposition 4: *With reputational concerns, there exists a perfect Bayesian equilibrium in which agent 2 follows the signal of the agent with the highest initial reputation.*

Because this proposition is very similar to *Proposition 3*, we will not discuss it entirely. We will only show the graphs that illustrate the behaviour of agent 2 for different initial reputations. In these graphs, s_* will denote the signal of the agent with the highest initial reputation.

When the agents receive the same signal, this graph illustrates the behaviour of agent 2 for different initial reputations (when we ignore whether or not λ is satisfied):



When the agents receive contrasting signals, this graph illustrates the behaviour of agent 2 for different initial reputations (when we ignore whether or not λ is satisfied):

$$\frac{\theta_1 - p\theta_1}{p + \theta_1 - 2p\theta_1} \qquad \theta_1 \qquad \frac{\theta_1 p}{p + \theta_1 - 2\theta_1 p - 1}$$

$m_2 = s_*$	$m_2 \neq s_*$	$m_2 \neq s_*$	$m_2 = s_*$

Conclusion

If agents have different initial reputations, but there are no relative reputation concerns, agent 2 will always follow the signal of the agent with the highest initial reputation. His message will not hold any new information and will therefore be ignored by the manager.

Relative reputational concerns gives agents with a relatively high *ex-ante* reputation an incentive to mirror the decision of other agents, in order to remain the agent with the highest reputation. It gives agents with a relatively low *ex-ante* reputation an incentive to contradict the decision of other agents, in order to get a chance to overtake the reputation of the other agent and become the agent with the highest reputation. The higher λ is, the more agent 2 is inclined to follow the signal of the agent with the highest initial reputation, like he does when there are no relative reputational concerns.

When the two agents receive different signals (G,B or B,G), mirroring leads to a loss of information for the manager and contradicting leads to more information for the manager. When the two agents receive the same signal (G,G or B,B), contradicting leads to a loss of information for the manager and mirroring leads to more information for the manager.

Discussion

Like all theoretical models, the model used in this paper is a highly simplified model of reality, with the intend to clearly display the forces that drive the decision of agents when they face relative reputational concerns. Differences between the model and reality could potentially have a significant influence on the results. We will now discuss the implications that several alterations might have on these results.

Agents' payoff could depend on the payoff of the project as well, when the agent owns shares of the company or he receives a bonus that depends on the profit of the company he works for. Depending on the decision rule, this might make him more likely to send a message that will maximize the probability that the manager makes the right decision, instead of one that maximizes his own reputation.

In most cases, agents have the possibility to switch firms. Regarding switching firms, there are two possible scenarios: Either other firms can only observe the agent's rank in the hierarchy (his job title), or they can also observe the agent's absolute reputation. In the first scenario, the job title (and thereby his relative reputation) of an agent becomes more important, thus the effects of relative reputational concerns, as described in this paper, become stronger. In the second scenario, the reputation of an agent relative to his colleague becomes less important, since his payoff depends more on his reputation relative to all the agents in his field.

In the model used by (Scharfstein & Stein, 1990), smart agents receive correlated signals. The idea behind this is that smart agents are able to observe a certain indicator of the state, and dumb agents are not. If we would add this assumption to the model used in this paper, agents would be more inclined to follow the signal of other managers (regardless of their initial ranking) to improve their absolute reputation.

We assume that the manager will always observe the payoff of the project, regardless of whether it is implemented or not. If the manager would not be able to observe the payoff of the project if it is not implemented, then he would be less able to adjust the reputations of the agents. Depending on the voting rule, the agent with the best initial reputation might therefore have an incentive to advice not to invest. The agent with the worst initial reputation might have an incentive to advice to invest.

If agent do know their own type, smart agents would probably be more inclined to follow their own signal and dumb managers would be more inclined to follow the message of the other player.

However, the alterations that are discussed above will not take away the most important results of this paper: When agents face relative reputational concerns, the agent with the highest ex-ante reputation has an incentive to mirror the decision of his colleague and the agent with the lowest ex-ante reputation has an incentive to contradict the decision of his colleague. In the first case, agent 2 protects his relative reputation and in the second case, agent 2 gets a chance to improve his relative reputation.

In this paper, we assume that it is just as likely that the payoff of the project is positive, as that it is negative. Further research could examine how changing this would influence the behaviour of the agents.

From the manager's perspective, it is interesting to know which order and voting rule will maximize his utility. This could be further examined in further research.

Finally, a lot more research could to be done regarding the effect of relative reputational concerns on models that do not make use of sequential deliberation. Such as the ones discussed in the last paragraph of the literary review and models on committees.

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